PB-218 573

EVALUATION OF THE EMISSION REDUCTION WITH THE PERFECT CIRCLE RETRONOX SPEED CONTROLLED EGR SYSTEM

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Environmental Protection Agency
Ann Arbor, Michigan

October 1971

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Mobile Source Pollution Control Program
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16. Abstracts Preliminary evaluations indicated that the Perfect Circle Retronox device caused substantial reduction in total oxides of nitrogen emissions from passenger vehicles. Evaluation of the effectiveness of the device was initiated using three vehicles. A 1971 Chevrolet Impala equipped with a 400 CID engine, automatic transmission and a two-barrel carburetor was tested. This vehicle was tested in both the single and double solenoid valve configuration. A single solenoid valve system was installed on a 1963 Chevrolet Impala with a 283 CID engine, manual three-speed transmission, and two-barrel carburetor. A 1964 Plymouth Fury with a 318 CID engine, automatic transmission, and two-barrel carburetor was tested employing both the single and double solenoid valve systems. The vehicles were tested both in baseline and device equipped configurations by the 1972 Federal emission test procedure. The Retronox system demonstrates significant effectiveness in reducing oxides of nitrogen. In general these emissions can be reduced by over 50%. There also appears to be a smaller yet consistent reduction in hydrocarbon and carbon monoxide possibly resulting from increased fuel-air mixing hence more homogeneous delivery to the individual cylinders. It is anticipated that installation of the system will result in decreased fuel economy. Little adverse effect on driveability was noted or anticipated.

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Carbon monoxide
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17b. Identifiers/Open-Ended Terms
Retrofit devices
Perfect Circle Retronox device
Retronox device
Federal Test Procedure (1972)

17c. COSATI Field/Group 13B

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Background

Preliminary evaluations indicated that the Perfect Circle Retronox device caused substantial reduction in total oxides of nitrogen emissions from passenger vehicles. While the device is still in the development stage it appears that it has potential usefulness as a used-car retrofit device as well as potential for new vehicle applications.

Device

Basically the Retronox device is a speed controlled EGR and distributor vacuum advance cut-off system, both effective procedures for reduction of total oxides of nitrogen. Exhaust gas is picked up from the exhaust pipe under the car. An EGR valve is actuated by an engine vacuum controlled solenoid valve which in turn is controlled by a speed-sensing switch driven by the speedometer cable. When open, the EGR valve allows exhaust gas to flow into the intake manifold by means of a base plate installed under the carburetor. The speed sensing switch is also used to actuate a solenoid valve restoring distributor vacuum advance. This solenoid valve can be the same one as for the EGR system if it is desireable to restore vacuum advance and introduce exhaust gas recirculation at the same speed. Figure I and Figure II indicate the configurations, double and single solenoid, used for the 1971 Chevrolet. Figure III, A and B, indicates the similar configuration employed on the 1964 Plymouth. The system installed on the 1963 Chevrolet is similar to that employed in Figure IIIA. It should be noted that in the single solenoid valve applications a micro-switch is used to shut off EGR and cut-off vacuum advance during closed throttle operations.

Test Program

Three vehicles were employed to evaluate the effectiveness of the Perfect Circle Retronox device. The first car tested was a 1971 Chevrolet Impala equipped with a 400 CID engine, automatic transmission and a two-barrel carburetor. This vehicle was tested in both the single and double solenoid valve configuration. A single solenoid valve system was installed on a 1963 Chevrolet Impala with a 283 CID engine, manual three-speed transmission, and two-barrel carburetor. Finally a 1964 Plymouth Fury with a 318 CID engine, automatic transmission,and two-barrel carburetor was tested employing both the single and double solenoid valve systems.

The vehicles were tested both in baseline and device equipped configurations by the 1972 Federal emission test procedure as described in the November 10, 1970 Federal Register. The bag samples obtained by this constant volume sampling procedure were analyzed by FID analysis for hydrocarbons, NDIR analysis for CO and CO_2, and chemiluminescence analysis for oxides of nitrogen.

Results

Tables I, II, and III in the Appendix indicate the test results for the 1971 Chevrolet, 1963 Chevrolet, and 1964 Plymouth respectively. The following percent reductions over baseline were measured:

1971 Chevrolet	HC	CO	CO_2	NOx
1 solenoid valve	19%	10%	7% inc.	31%
2 solenoid valves	14%	1.9%	16% inc.	46%
1963 Chevrolet				
1 solenoid valve	32%	57%	0%	68%
1964 Plymouth				
1 solenoid valve	10%	6%	23% inc.	65%
2 solenoid valves	13%	11%	17% inc.	70%

It should be noted that the baseline emissions for the 1963 Chevrolet were made without the carburetor base plate in position. The added fuel-air mixing caused by this plate may account for the significant reduction in carbon monoxide.

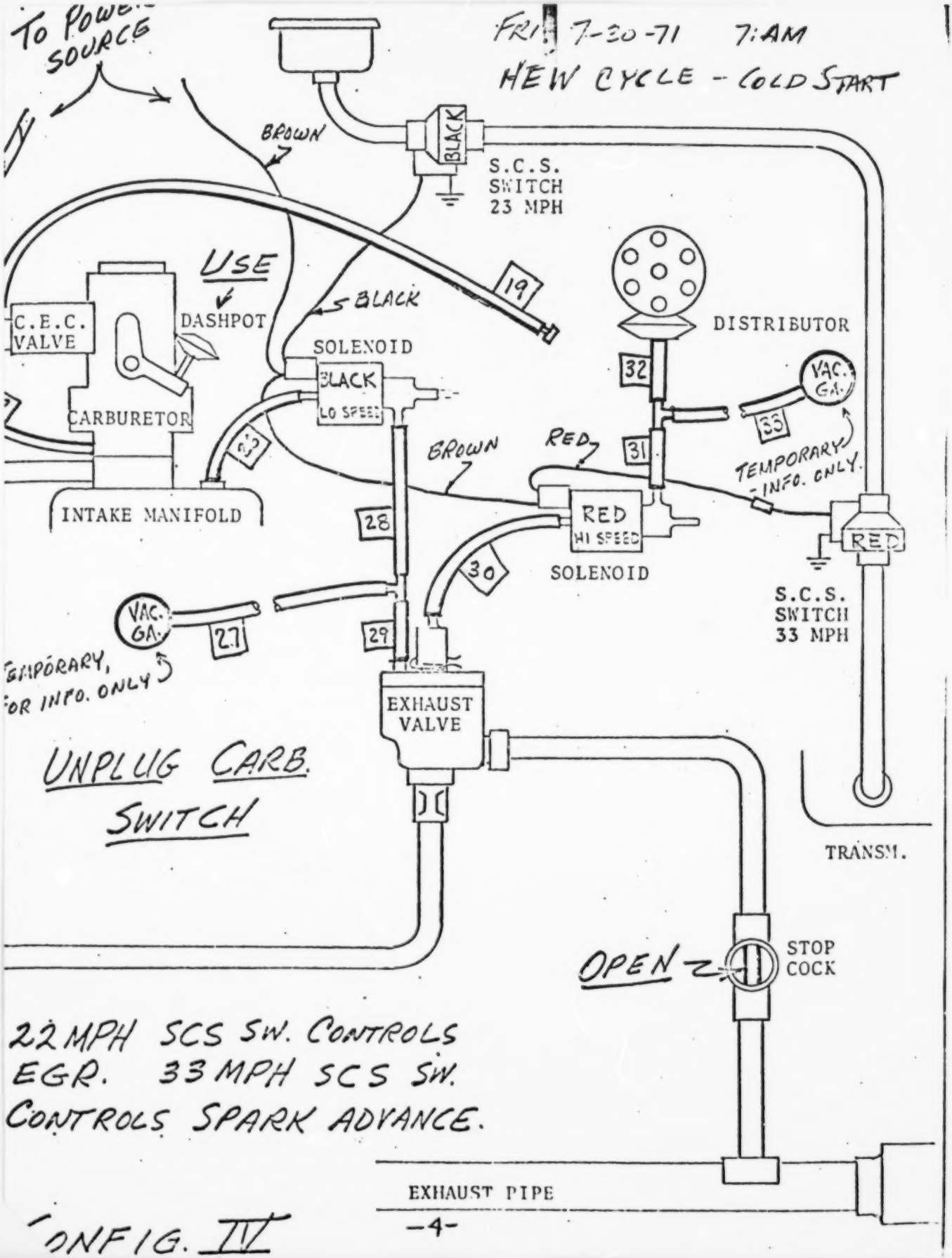
The Plymouth was operating quite rich (10% carbon monoxide at idle) indicating that certain cylinders may have experienced occasional misfire due to rich limit combustion. This may account for the increase in hydrocarbon emissions measured during the evaluation.

Conclusions

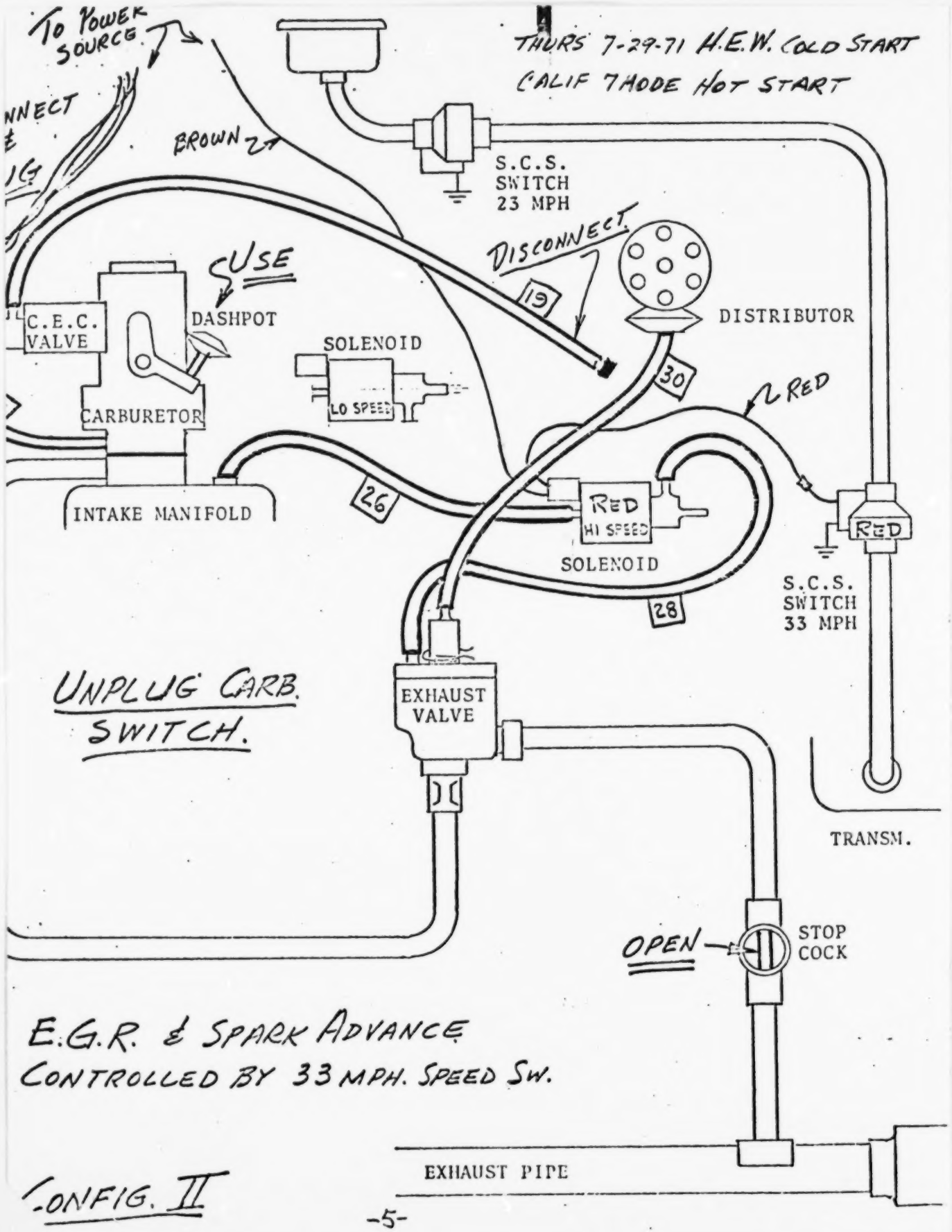
The Retronox system demonstrates significant effectiveness in reducing oxides of nitrogen. In general these emissions can be reduced by over 50%. There also appears to be a smaller yet consistent reduction in hydrocarbon and carbon monoxide possibly resulting from increased fuel-air mixing hence more homogeneous delivery to the individual cylinders. It is anticipated that installation of the system will result in decreased fuel economy. This observation is supported by the increases seen in carbon dioxide emissions during the evaluations.

Little adverse effect on driveability was noted or anticipated as the system does not initiate EGR during the most sensitive engine operating modes; e.g. low vehicle speed power operations.

The cost of the system will be a crucial parameter in the consideration of Retronox as a retrofit device. Since the system is still in the development stage little idea as to the installed cost to the individual consumer is available.

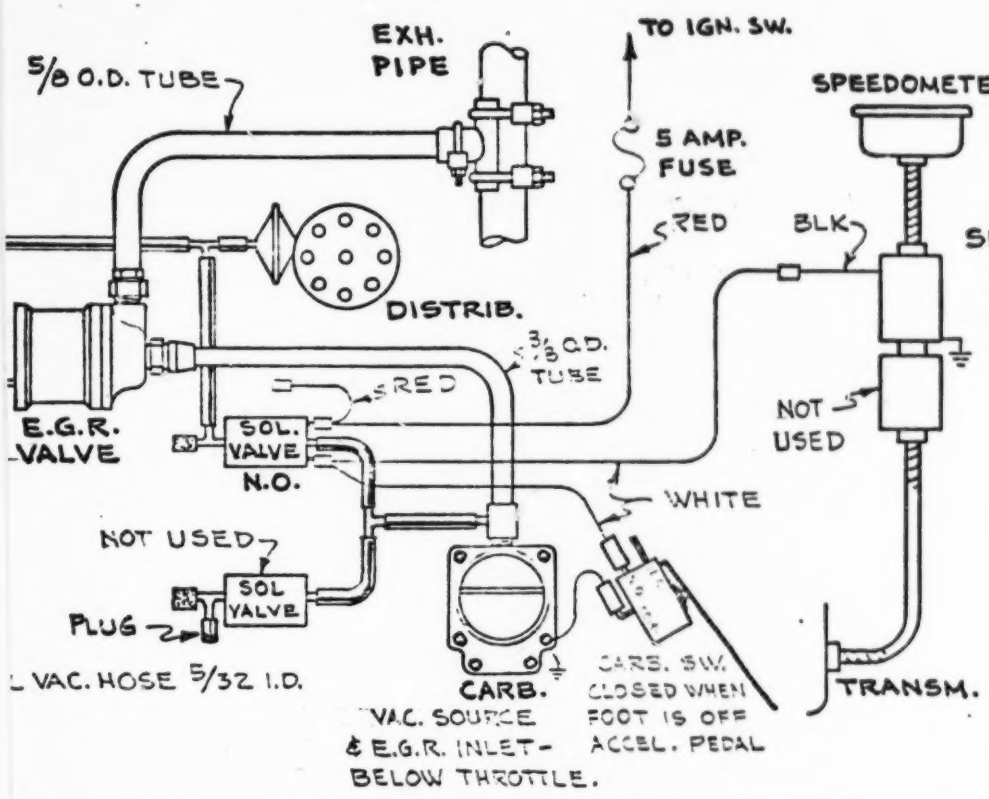

TO POWER SOURCE
FRI 7-30-71 7:AM
NEW CYCLE - COLD START
BROWN
BLACK
S.C.S. SWITCH 23 MPH
USE
DASHPOT
C.E.C. VALVE
CARBURETOR
INTAKE MANIFOLD
BLACK
SOLENOID
LO SPEED
19
DISTRIBUTOR
32
VAC. GA.
35
TEMPORARY - INFO. ONLY.
BROWN
RED
31
RED
HI SPEED
SOLENOID
28
30
RED
S.C.S. SWITCH 33 MPH
VAC. GA.
27
TEMPORARY, FOR INFO. ONLY
29
EXHAUST VALVE
UNPLUG CARB. SWITCH
TRANSM.
OPEN
STOP COCK
22 MPH SCS SW. CONTROLS EGR. 33 MPH SCS SW. CONTROLS SPARK ADVANCE.
EXHAUST PIPE

CONFIG. IV


To Power Source
THURS 7-29-71 H.E.W. COLD START
CALIF 7MODE HOT START
BROWN
S.C.S. SWITCH 23 MPH
DISCONNECT
USE
19
C.E.C. VALVE
DASHPOT
DISTRIBUTOR
SOLENOID
LO SPEED
30
RED
CARBURETOR
INTAKE MANIFOLD
26
RED
HI SPEED
SOLENOID
RED
S.C.S. SWITCH 33 MPH
28
UNPLUG CARB. SWITCH.
EXHAUST VALVE
TRANSM.
OPEN
STOP COCK
E.G.R. & SPARK ADVANCE
CONTROLLED BY 33 MPH. SPEED SW.
EXHAUST PIPE
CONFIG. II

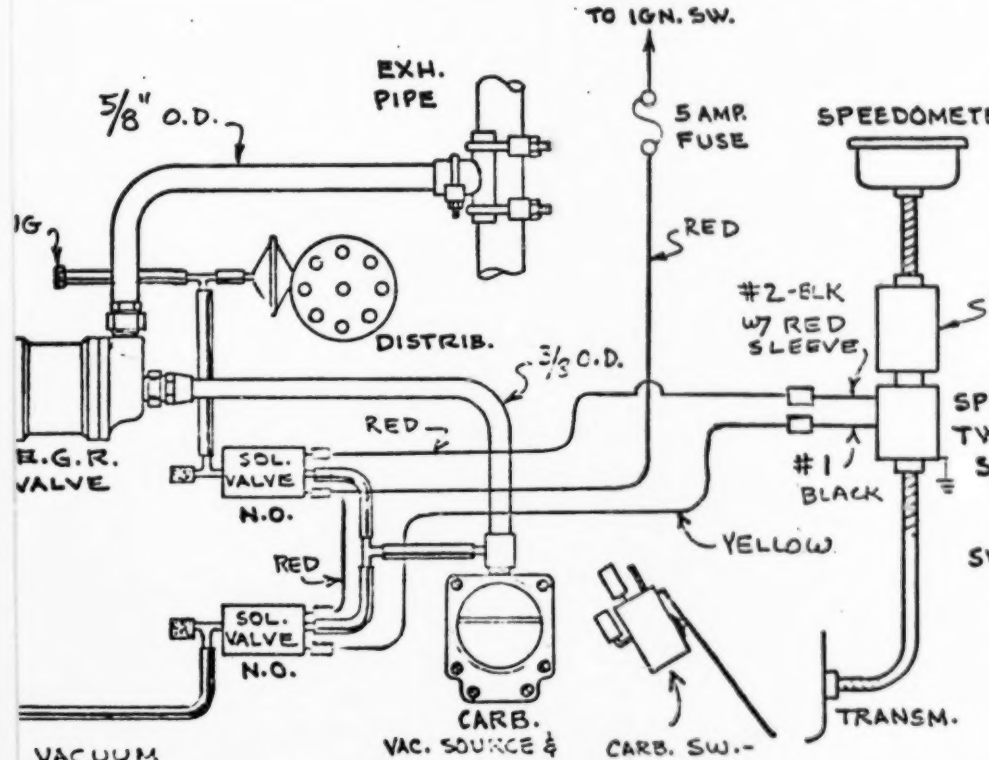
2V Stromb., 9:1 Comp. R., Automatic Transm.,-Gross Wt. 3700 lbs.

A



P-C DANA RETRONOX SYSTEM #4

B



P.C.- DANA RETRONOX SYSTEM #4

Table I

1971 Chevrolet Impala Emissions
(grams per mile)

1972 FTP

		HC	CO	CO_2	NOx
Baseline		4.0	63.4	701.9	3.4
		3.3	65.1	753.9	3.5
	Average	3.7	64.3	727.9	3.5
Retronox (one switch system)					
		3.0	57.7	779.9	2.4
	% Reduction over baseline	19%	10%	7%	2.4
Retronox (two switch system)					
		3.2	51.9	845.7	1.9
	% Reduction over baseline	14%	19%	16% inc.	46%

Table II

1963 Chevrolet Impala Emissions
(grams per mile)

1972 FTP

		HC	CO	CO_2	NOx
Baseline		8.3	113.8	404.5	1.4
Retronox (one switch system)					
		4.7	47.5	---	.34
		6.5	50.6	401.9	.56
	Average	5.6	49.1	401.9	.45
	% Reduction over baseline	32%	57%	0%	68%

Table III

1964 Plymouth Fury Emissions
(grams per mile)

1972 FTP

	HC	CO	CO_2	NOx
Baseline	7.5	116.4	418.1	3.7
Retronox (one switch system; common EGR inlet and vacuum source)	6.8	109.9	513.6	1.3
% Reduction over baseline	10%	6%	23% inc.	65%
Retronox (two switch system; common EGR inlet and vacuum source)	8.5	103.4	491.5	1.1
% Reduction over baseline	-13%	11%	17% inc.	70%